Infraclavicular Subclavian Angiography By Percutaneous Puncture

ANSELMO PINEDA, M.D., EDWARD O. GAMMEL, M.D.
ROGER A. SLATER, M.D., *Long Beach*

■ *Successful visualization of the extracranial circulation and posterior basilar-vertebral complex was accomplished with a modified technique for direct percutaneous infraclavicular puncture of the subclavian artery.*

The advantage of the described method over other methods relates to the simplicity and safety of the technique. The advantages outweigh the not serious complications which may be encountered.

ANGIOGRAPHIC VISUALIZATION of the vertebral basilar complex is often necessary in suspected vascular occlusive disease, in subarachnoid hemorrhages and in vascular insufficiency due to cervical spondylosis or cervical trauma. For these studies, different approaches have been used in the past.[6,9,10] The limitations of such methods for use as routine procedures are the excessive time required and the frequent complications.

Subclavian injection appeared to be the most logical method of demonstrating the origin of the vertebral artery and of avoiding the hazards of vertebral artery puncture. Since supraclavicular approach for the subclavian puncture, described by many investigators (Baker,[2] Barbieri and Verdecchia,[3] Crawford and coworkers,[4] Shimidzu[9] and others) often produces pneumothorax and hemomediastinum, a more convenient and less hazardous modification of the procedure was sought. Puncture of the third portion of the subclavian artery infraclavicularly rather than of the first portion of the vessel seems to greatly minimize possible complications.

We have used this site in more than eighty cases. Our modified technique assures consistently a successful puncture of the subclavian artery without having a serious complication.

Review of Infraclavicular Technique

Pouyanne and coworkers (1960)[7] were the first to describe the subclavicular approach. When the subclavian artery is not palpable they seek for a point which, upon compression, will occlude the pulsation of the radial artery, and they redirect the needle to that target. Amplatz and Harner (1962)[1] suggested that the insertion of the needle be made one finger width lateral to the midclavicular line and about one finger width below a line passing transversely through the jugular notch. Weibel and Fields (1963)[11] introduced the needle subclavicularly at the point of the junction of the internal and middle third of the clavicle. Ray (1963)[8] used a landmark initially located by halving the distance between the sternal notch and acromial tip of the clavicle. The needle was

From Veterans Administration Hospital, Long Beach, and University of California Medical Center, Los Angeles.
Submitted August 13, 1964.

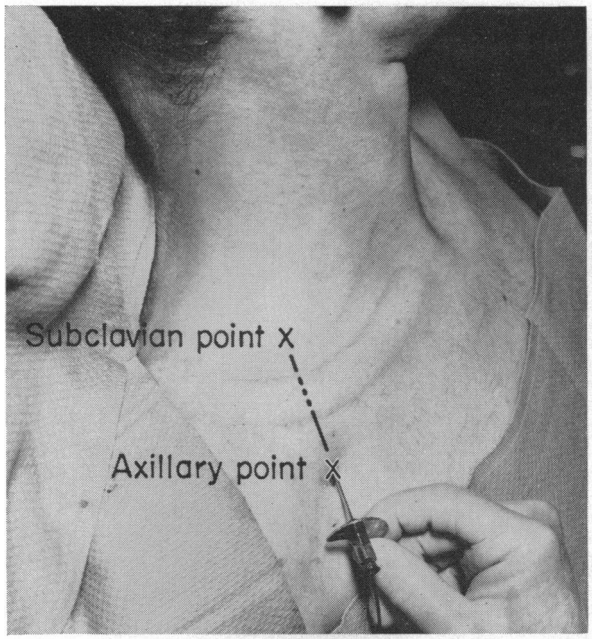

Figure 1.—The picture illustrates the orientation of the needle in the subclavian artery. Infraclavicularly the needle is directed along the line traced between the axillary point (Mohrenheim's triangle) and the subclavian point.

inserted subclavicularly in an ascending direction aiming toward the subclavian triangle formed by the scalenus anticus, the subclavian artery and the first rib. The needle was guided toward the scalenus anticus muscle itself or even more medially.

Technique

The patient is given 65 to 130 mg (1 to 2 grains) of sodium luminal one hour before the test. On the x-ray table a large rubber sponge or small pillow is placed between his shoulder blades helping to hyperextend both shoulders. The arms are gently pulled down or are placed in abduction, whichever is better.

The landmarks used to identify the site of the puncture are the subclavian artery in the subclavian triangle and the axillary artery in the delto-pectoral space (Mohrenheim's triangle*). The line between these two points will orient the insertion of the needle (Figure 1). Approximately 4 ml of 1 per cent procaine hydrochloride is injected one inch below the clavicle at the level of the palpable axillary artery. A Cournand-Grino needle is introduced at the point after a bore-hole on the skin is made with an 18 gauge needle, and is directed to penetrate the third portion of the subclavian artery (Figure 2) in the supraclavicular fossae. The likelihood that the target vessel will be punctured properly is enhanced by following these guides, since the needle so oriented will encounter the vessel in its long axis. The penetration of the vessel is confirmed when the subclavian artery pulse disappears or decreases as the result of compression by the needle. At times the first portion of the axillary artery will be penetrated (Figure 2). A rather vigorous blood flow is obtained when the inner needle is removed.

Care should be taken to prevent injury to the median nerve running in front of the third portion of the axillary artery. In this region the lateral and medial cords of the brachial plexus join to form the median nerve at the level of the teres major muscle. If the needle is directed too low, it may injure the nerves. When approaching the axillary artery area, the needle should not be directed too far medially because of the danger of penetrating the pleura.

If subclavian pulsations are weak or absent, an intravenous injection of metaraminol (Aramine®) 1 to 3 mg is given to elevate the blood pressure. This adjunct greatly facilitates puncturing the artery. The opposite subclavian artery may be punctured in the same manner.

A spot film is taken after injection of 3 ml of contrast medium (Hypaque®). This film will help to evaluate the x-ray penetration; to visualize the position of the needle in relationship to the wall of the artery, and to detect any faulty injection.

A series of anterior-posterior x-ray films, centered to include both sides of the neck, are taken 0.5 per second apart, and followed by an anterior-posterior intracerebral angiogram, made either from the right or the left side. Lateral views including both neck and head are then taken. Four to five exposures are made for visualizing the neck and eight to ten for demonstrating the intracranial circulation. A blood pressure cuff previously placed on the arms is inflated to 180 mm of water immediately before each injection. The injection is made rapidly by hand pressure, exposures being made when half of contrast material has been introduced for visualizing neck vessels and when injection is complete for head views.

At the conclusion of the study, the needles are withdrawn and the site of the punctures compressed for three minutes.

*From Gray's "Anatomy"[5]: The Mohrenheim's triangle is the interval between the adjacent borders of the Deltoideus and Pectoralis major.

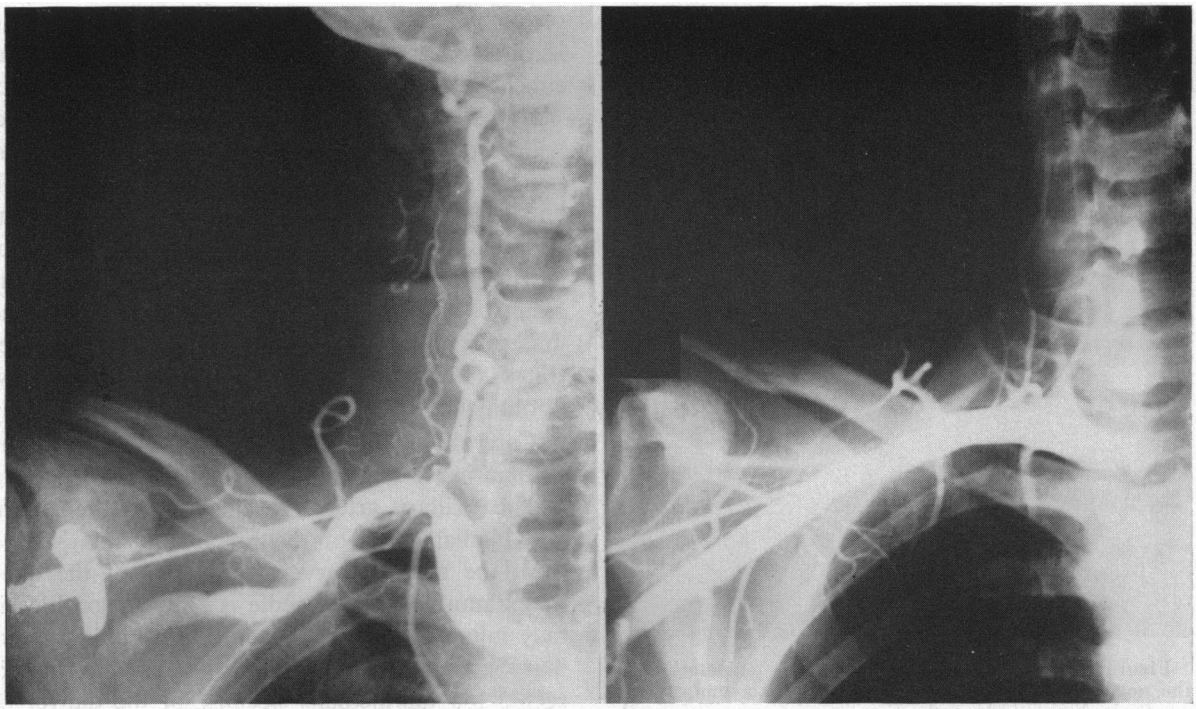

Figure 2.—The angiogram at the left shows that the needle is located in the third portion of the subclavian artery. In another study, right, the needle has punctured the first portion of the axillary artery.

Results

Patients were selected for subclavian angiography because of symptoms suggesting arteriosclerotic ischemia of the brain. Severe diffuse arteriosclerosis, unbalanced cardio-pulmonary insufficiency and active myocardial infarction were considered to be relative contraindications for the studies. Age was not a limitation, but the eldest patient studied was 71 years of age.

Both the subclavian and the vertebral arteries (as in Figure 3) were well demonstrated in every instance. The basilar artery and the posterior cerebral arteries were excellently visualized (see Figure 4). The right carotid was seen inconsistently and approximately 0.5 to 0.7 of a second after the vertebral artery came into view. Such visualization made it possible to demonstrate atheromatous plaques at the bifurcation of the carotid artery in the neck. The intracerebral visualization of the carotid system resulting from subclavian injection on the right side lacked good contrast at times, but angiograms so obtained were diagnostic in the majority of cases. Subclavian injection on the left side never caused such visualization. The lack of adequate outline of the right carotid artery may have something to do with the position of the needle in the subclavian artery, particularly when the injection is impeded by location of the needle orifice against the posterior wall of the vessel. When this occurs the needle must be withdrawn about 3 mm away from the intima into the lumen of the artery. This maneuver will also prevent a subadventitial or subintimal injection. The scout film originally taken will reveal the need for this modification.

As the left common carotid artery was never demonstrated with left injection of the subclavian vessel, percutaneous puncture of this vessel was always done to complete the study of the four vessels.

With this method, the head and neck can be turned without fear of dislodging the needle. Direct trauma to the vertebral artery is prevented, and the hazards of vertebral artery spasm due to direct puncture are greatly minimized. Furthermore, visualization of posterior fossa vessels is as satisfactory by this method as in direct vertebral injection.

Complications

In five of eighty cases, we were unable to puncture the subclavian artery. One of the patients had an acute clavicle angle and the other four were obese. Subadventitial extravasation (Figure 5) of the contrast medium occurred in three cases. It caused little discomfort to the patient. A

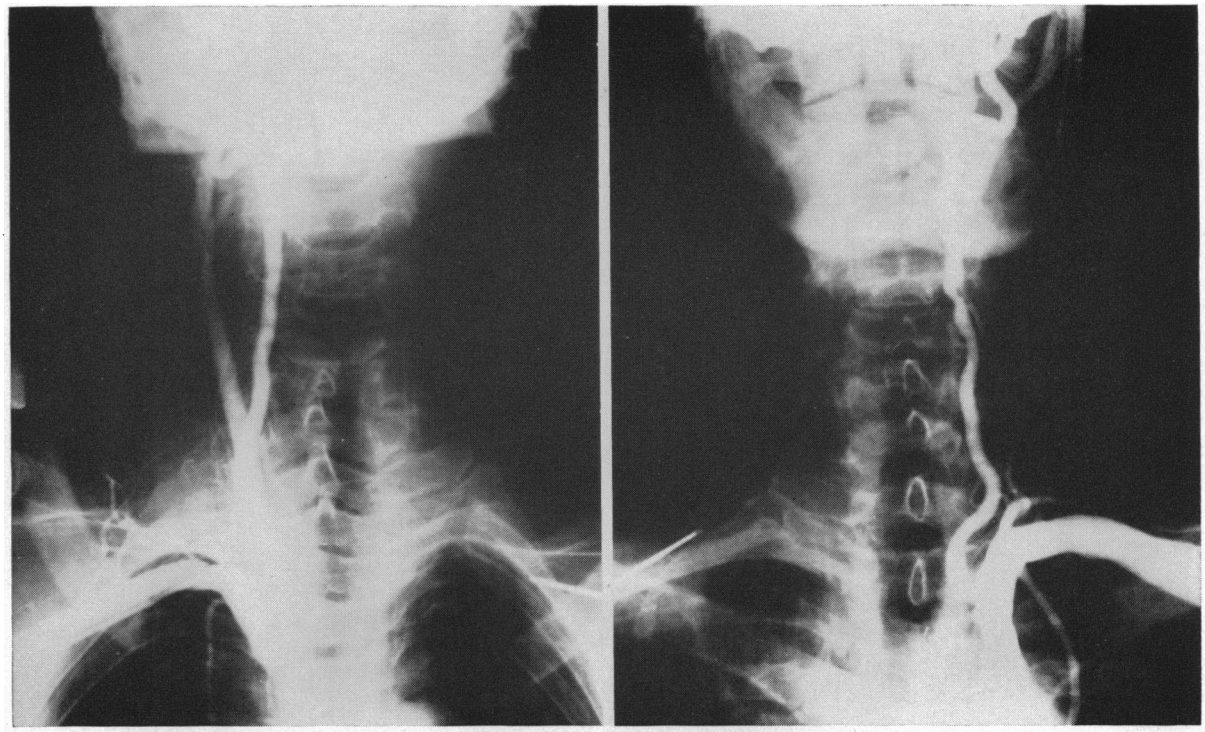

Figure 3.—These neck views visualize the extracranial circulation. Injections have been made bilaterally: In the film at the left, the right subclavian, the vertebral and the common carotid arteries are well visualized. An atheromatous plaque is present in the carotid bifurcation. *Right,* the left subclavian injection visualizes the subclavian and the vertebral arteries. Atherosclerotic changes are seen in the latter artery.

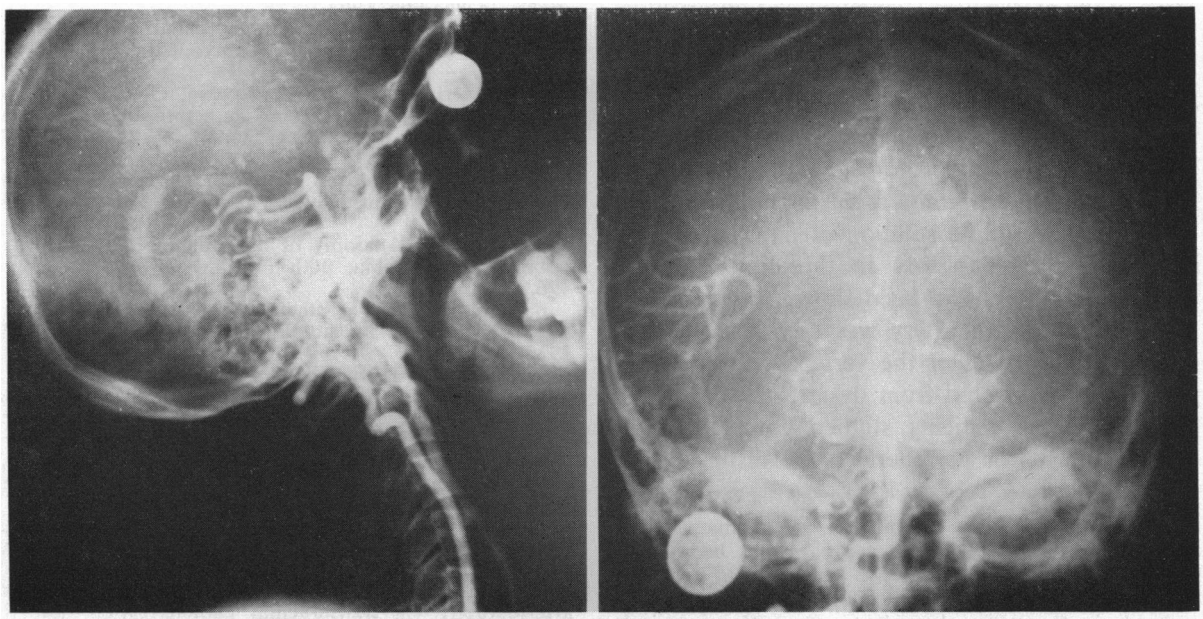

Figure 4.—*Left,* Lateral view of the neck and skull following subclavian injection, shows excellent visualization of the intracranial circulation. *Right,* Anteroposterior view demonstrates all branches in the posterior circulation. Note the middle cerebral artery, visualization on both sides.

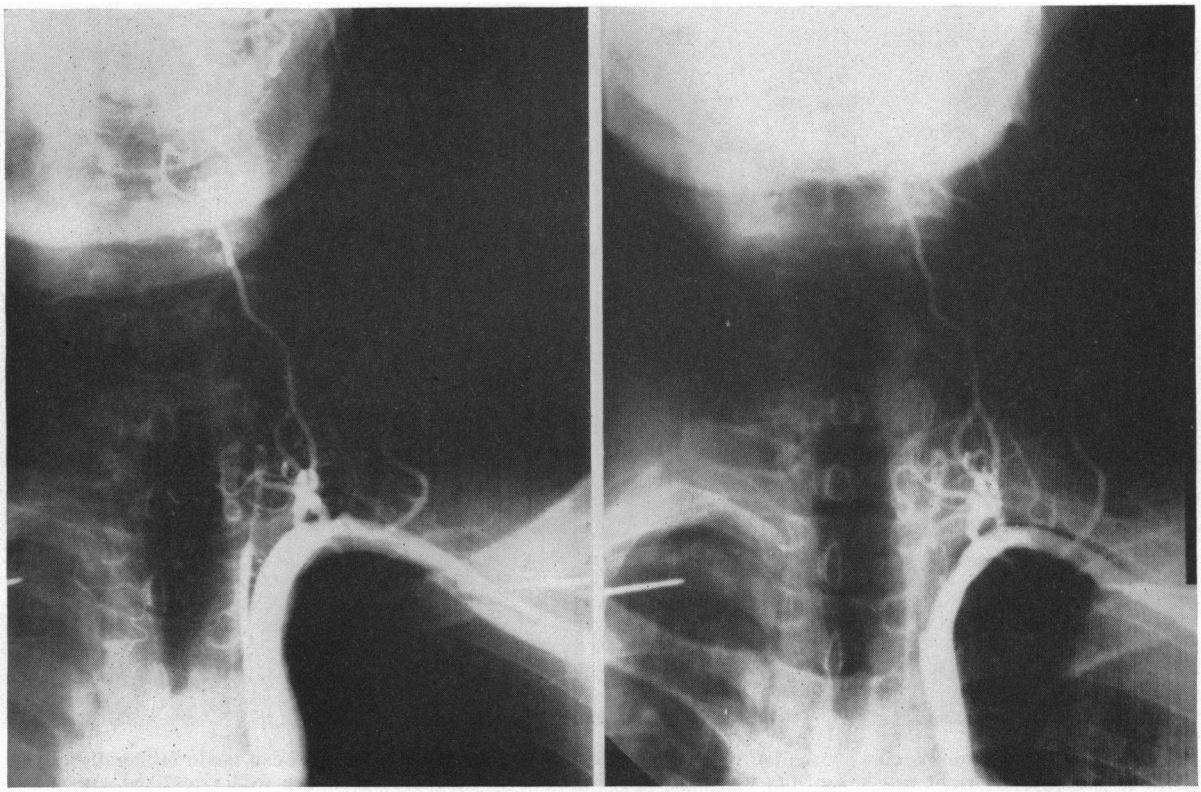

Figure 5.—*Left,* the angiogram shows faulty subadventitial injection extending downward to the origin of the subclavian artery. *Right,* following repositioning of the needle in the same patient, a narrow lumen of the vessel is demonstrated. The patient was found to have a complete occlusion of proximal two thirds of the vertebral artery. There was a well developed collateral circulation present, especially through the ascending and the costo-cervical branches as well as through the branches of the external carotid artery.

successful angiogram was obtained immediately after readjustment of the needle (Figure 5). No trace of the extramural Hypaque® was observed in repeat films taken a few minutes later.

In one patient with atheromatous plaque at the origin of the left vertebral artery, injection caused severe spasm of the vessel. This complication provoked a return of dysarthric symptoms which had been among the early and recurring complaints of this patient. A dilute solution of papaverine (30 mg) was injected slowly in the opposite subclavian artery that had been shown to be patent. The left subclavian artery was then revisualized, demonstrating relief of the vertebral spasm. The patient had recovered from dysarthria.

None of the patients studied complained of brachial plexus or peripheral nerve disturbances.

5901 East 7th Street, Long Beach, California 90804 (Pineda).

ADDENDUM: Since the submission of this manuscript, the infraclavicular subclavian approach has been used in an additional 90 cases at the Long Beach Veterans Administration Hospital. This technique is now employed routinely by the staff and residents of our Neurosurgical Section. A single case of mild pneumothorax has occurred with no significant consequence. There have been no other complications in this group of cases.

REFERENCES

1. Amplatz, K., and Harner, R.: New subclavian artery catheterization technique. Preliminary report, Radiology, 78:963-966, 1962.

2. Baker, H. L., Jr.: A new approach to percutaneous subclavian angiography, Proc. Mayo Clin., 35:169-174, 1960.

3. Barbieri, P. L., and Verdecchia, G. C.: Vertebral arteriography by percutaneous puncture of the subclavian artery, Acta Radiologica. Stockh., 48:444-448, 1957.

4. Crawford, E. S., DeBakey, M. E., and Fields, W. S.: Roentgenographic diagnosis and surgical treatment of basilar artery insufficiency, J.A.M.A., 168:509-514, 1958.

5. Gray, H.: Anatomy of the Human Body. Lea and Febiger, Philadelphia, 26th Edition, pp. 1480. See pp. 496, 1954.

6. Lindgren, E.: Percutaneous angiography of the vertebral artery, Acta Radiologica. Stockh., 33:389-404, 1950.

7. Pouyanne, H., Caillon, F., Leman, P., Got, M., Salles, M., and Gouaze, A.: L'angiographie vertebrale par voie sous-claviere sous-claviculaire, Neurochirurgie, 3:35-45, 1960.

8. Ray, C. D.: Intracranial angiography by percutaneous puncture of the subclavian artery utilizing a subclavicular approach, J. Neurosurg., 20:400-405, 1963.

9. Schimidzu, K.: Beitrage zur arteriographie des Gehrnseinfache percutane method, Arch. Klin. Chir., 188:295-316, 1937.

10. Tatelman, M., and Sheehan, S.: Total vertebral arteriography via transbrachial catheterization, Radiology, 78:919-929, 1962.

11. Weibel, J., and Fields, W. S.: Direct percutaneous infraclavicular catheterization of the subclavian artery, J. Neurosurg., 20:233-237, 1963.